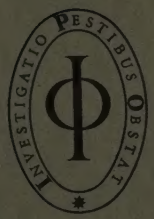
INSTITUUT VOOR PLANTENZIEKTENKUNDIG ONDERZOEK
WAGENINGEN, NEDERLAND
DIRECTEUR: Dr. J. G. TEN HOUTEN

MEDEDELING No 254

AERIAL SPRAYING AGAINST LATE BLIGHT OF POTATOES

DOOR

J. G. TEN HOUTEN EN M. C. KERSSEN



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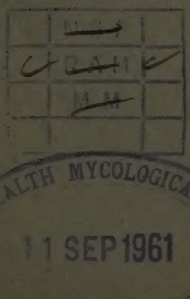

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XX, 10

Aerial spraying against late blight of potatoes*

During several years of experimentation on the possibilities of the use of aircraft, for the control of plant diseases, insect pests and weeds, sufficient data were collected by the Institute for Phytopathological Research to enable private companies in the Netherlands to start operations on a practical scale. At present six companies are involved in this type of spraying; one working with helicopters, the others with fixed wing aeroplanes, type Piper Super Cub P. A. 18 A. The total agricultural area sprayed this way is expanding year after year. In 1954 14 000 ha were treated, in 1955 18 000 ha, and in 1956 about 25 000 ha. These figures were obtained from the aerial spraying companies. The actual agricultural area treated was smaller, because several plots (e. g. potatoes) have been sprayed more than once. As aerial spraying is economical only for larger fields, it is reasonable that it is carried out mainly in the polder areas. Spraying against insect pests such as cabbage seed pod weevil *(Ceuthorrhynchus assimilis)* in colza, pea insects *(Contarinia pisi* and *Enarmonia nigricana)*, and beet fly *(Pegomyia hyoscyami)* as well as weed control on grassland are normal practices, but the most important objective for aerial spraying in Holland is undoubtedly the control of potato late blight, amounting to about 40 % of the total acreage treated from the air.

Because the application of fungicides is a means of preventing the parasitic fungus *Phytophthora infestans* from establishing itself in the leaves, spraying must be repeated at regular intervals. Susceptible varieties like the ware and seed potatoes Bintje and Eigenheimer get 4—7 applications. In contrast industrial potatoes, being less susceptible and needing no long storage, are sprayed only 1—3 times. The first application on susceptible varieties usually takes place when plants are large enough to be touching one another in the rows. This normally falls between the first and third week of June. Less susceptible varieties are treated for the first time when initial infection in adjacent fields, planted with susceptible varieties, has been observed. Further sprayings are carried out after 7—20 days depending on weather conditions and growth. If weather conditions are favourable for infection this is broadcasted by radio.

Until 1952 only copper compounds were used for blight control. Careful field experiments carried out with ground atomizers by Ir. DE LINT (1957) and others from the Netherlands Plant Protection Service have shown that the potato yield was higher if zineb was used (at a rate of 3—5 kg/ha) instead of copper compounds. However, on clay soils in $^2/_3$ of the cases observed, control of leaf infection was less than with copper compounds. As a result tuber infection in the unsprayed plots and in the zineb-treated plots was twice as high as on the copper-treated plots. If weekly applications of zineb were given, the results were much better. However, it is doubtful whether such frequent sprayings will be economical. Therefore combined treatments were investigated. Results were best when the first two applications carried out with zineb were followed by subsequent copper sprayings. In 1956 this scheme was used in nearly 40 % of all sprayings against late blight and in 55 % of the sprayings on clay soils. The same scheme and chemicals used by ground equipment are applied by airplanes.

For economical reasons it is essential in aerial spraying that the amount of spray liquid per acre should be kept as low as possible. At the moment we do not dare to go below 30—45 l/ha when fungicides are applied. By using finer nozzles the dosage can be diminished, but then the number of droplets per cm^2 is also less. The result will be an insufficient coverage of the crop, allowing incidental fungus spores to germinate and to infect the leaves. Once the leaves have become infected the disease will spread regardless of further fungicidal applications.

When using aircraft we apply the same amount of fungicide as used in high volume spraying. This means that very high concentrations of the fungicides have to be used. Here several difficulties arise especially with copper compounds. The first copper spray applied after the two initial zineb sprayings (with 3 kg zineb/ha) contains, as a rule, 7 kg copperoxychloride in 35—45 l, whereas the last copper spray applied contains 10 kg copperoxychloride in 35—45 l. If no special precautions are taken, clogging of the nozzles will result. Because of these circumstances the aerial spraying companies showed a keen interest in a new type of copper spray, a so-called colloidal copper, sold as a paste. Not only was this product much easier to mix, but due to its colloidal nature it did not clogg and stayed in suspension well. Careful experiments showed that these new preparations unfortunately have a tendency to give less protection against *Phytophthora* late blight than copperoxychloride.

To get an answer on this important question, this year carefully planned field experiments have been carried out in which the effect of both types of copper spray was compared. One of these experiments

* Read by J. G. TEN HOUTEN.

was carried out on the very susceptible variety Bintje. After two sprayings with zineb, half of the plots received three additional sprayings with colloidal copper (9, 12 and 12 l/ha respectively) and the other half was sprayed with copperoxychloride (5, 10 and 10 kg/ha respectively). The airplane used was a Piper Super Cub equipped with 46 spraynozzles of Spraying System Inc. The nozzles D 6 and D 8—45 were used alternatively. Pressure on the spray liquid was 40 psi, and speed of the plane 70 mph. The amount of liquid per ha was 45 l.

The last (5th) application of fungicides took place on July 29. At that time a slight infection was found in the plots treated formerly with zineb and colloidal copper. Due to the weather conditions favourable for the spread of the disease, the final examination of leaf infection took place on August 6, whereas the haulms were killed with chemicals on August 9.

On August 6 evaluation of the disease took place in the usual manner, using figures for the health conditions of the plants in which 10 means no infection and 0 totally destroyed foliage. At that time the average health figure for the plants treated with copperoxychloride was 8, against 4—5 for the plots with colloidal copper.

The result of this trial is clear. The rather low concentrated colloidal copper used in this experiment was far less effective than copperoxychloride. This means that unless better colloidal coppers are available future aerial spraying against late blight should be with copperoxychloride. This brings us back to the difficulties involved in the application of concentrates of this chemical. First of all the copperoxychloride spray has to be prepared in a non-corrosive cylindrical tank on the ground. A stirring device keeps the suspension from settling. When filling the stainless steel liquid tank of the airplane the diluted suspension is poured through a sieve. When pumping the spray liquid to the nozzles (for which purpose a centrifugal pump is used) some of the liquid runs back via an overflow. This provides some agitation to the suspension. All connecting pipe-lines consist of messing. The Spraying System nozzles used have a rather wide orifice (D 6 = 2.5 mm and D 8 = 3.3 mm). Sometimes disc-sprayers are used, having an orifice width of 4 mm. Both types of nozzles give large droplets compared with the droplet sizes produced by ordinary low volume sprayers (fig. 1). Moreover the number of droplets per cm^2 is less.

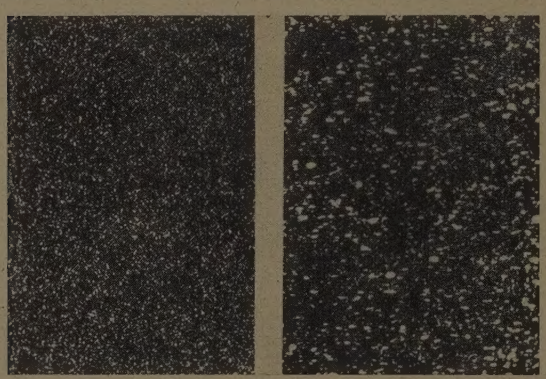

Fig. 1. Size of droplets produced by ordinary low-volume sprayers (180 l/ha) and by aerial spraying (45 l/ha). (½ of normal size).

The fact that blight control is still satisfactory must be due to a redistribution of the copper compound over the leaf surface when dew or rain wets the plant. A sticker is often added in order to improve the sticking qualities of the spray. However, it is not desirable to add the same amount of sticker as used in high volume spraying, because it has been found that this amount is much too high for the small volume of concentrated spray applied with an airplane. The result may be, and in fact has been, that tuber infection is higher. This problem will be studied more in detail by Mr. RIEPMA, working at our Institute.

Dr. FRANSEN and Miss KERSSEN (1952, 1954) have been studying droplet sizes and spray distributions obtained with different types of nozzles, airplanes and helicopters under varying conditions for many years. The results of their work are also used in the control of late blight of potatoes. It has been found, for instance, that the best distribution of the spray is obtained when flying at an altitude of 1.5 to 2 m using Spraying System nozzles. With disc sprayers the desired flying height is 2—3 m. The swathe appears to be 15 m with a Piper Super Cub and with helicopters it is 14 or 20 m. Best coverage and overlap of the runs are obtained with a slight side wind. Maximum wind velocities for successful work are 6—7 m/sec.

Since 1951 annual trials for the control of late blight have been carried out with aircraft and ground atomizers simultaneously. The amount of liquid varied for the aircraft from 30—45 l/ha and for the ground atomizer from 120—400 l/ha. Distribution of the spray and droplet sizes were estimated by placing glass plates in a row at right angles to the run of the atomizer or airplane. It was found that with the airplane a more even distribution was obtained. In most cases control of leaf infection was slightly better with the ground machine, but the final yield of healthy potatoes was practically the same because of the wheel damage caused by the ground sprayer. This wheel damage according to Ir. DE LINT and others was found to be 3—4 % of the total yield. We therefore may conclude that aerial application of fungicides for the control of potato late blight gives the same results as spraying with ground equipment. An advantage of the use of aircraft is the possibility to spray large acreages in a very short time. A disadvantage is the greater susceptibility for wind velocities above 7 m/sec.

HOHENER (1952) suggests that the very high fungicidal concentration used for aerial application provides extraordinary rain resistance, resulting in long lasting protection of the crop. This has not been substantiated in our trials where rain resistance appeared to be the same with ground atomizers and with aircraft, notwithstanding the fact that

the fungicidal concentration was 10 times higher in aerial spraying.

Careful measurements of the copper residues (method of MARTIN, 1955) on potato leaves by Miss KERSSEN and Ir. RIEPMA have demonstrated that the penetration of the spray liquid into the crop was independent of the apparatus used. If one puts the amount of copper residue found on the top leaves at 100, the middle canopy got ± 75, whereas the bottom leaves got only 8.

In normal years 6 sprayings with fungicides on susceptible varieties, such as Bintje and Eigenheimer, are still quite profitable from an economic standpoint according to measurements carried out by Ir. DE LINT (1957). For less susceptible varieties (e. g. Voran), which are mainly used as industrial potatoes or for cattle food, the profitable limit lies at 2—3 applications (BOESJES and KETELAAR 1955).

However, notwithstanding careful research on the epidemiology and control of potato late blight and intensive spraying based on radio warnings, the annual loss due to this disease is estimated by MASTENBROEK (1952) to be 15 million guilders + 5 million guilders for the cost of spraying. Recent estimations of Plant Protection Service are still higher. Improving our spray techniques, and further investigations on the best chemicals and concentrations to be used, as well as hygienic measures (e. g. eradication of infection centers derived from diseased tubers) will be necessary in order to reduce this loss. It seems that aerial spraying against potato late blight will become more and more an established procedure in our fight against this serious threat to one of our most essential food crops.

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